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COMPARATIVE VERIFICATION OF GUIDANCE AND LOCAL FORECASTS OF PRECIPITATION TYPE

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A system for predicting the conditional probability of frozen precipitation (PoFP(P)) has been operational within the National Weather Service (NWS) since November 1972. The development of the PoFP(P) system is described in detail by Glahn and Bocchieri (1974). Because the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972) was used in the development, the system is usually referred to as MOS PoFP(P). The operational products include both a facsimile chart and a teletypewriter message; details as to the availability of the operational products to field offices may be found in NWS (1973a, 1974a, 1974b).

In September 1973, a new combined aviation/public weather forecast verification program went into effect within the NWS. This new program is referred to as the "NWS verification" in this paper. The operational procedures, scoring system, and management of the NWS verification of aviation terminal forecasts and public forecast elements of surface wind, amount of clouds, and precipitation type are described in NWS (1973b). In the NWS verification, each Weather Service Forecast Office records the official aviation and public weather forecasts for two stations--its own station and one other station for which it prepares forecasts. The "local" forecasts referred to in this study are those which have been archived as part of this NWS verification.

Local forecasts are issued at about 1000 GMT and precipitation type is recorded for the valid times 1800 GMT (today), 0600 GMT (tonight), and 1800 GMT (tomorrow) as a single digit according to the code:

Code Number	Meaning
1	drizzle
2	rain
3	rain showers, hail
4	snow
5	snow showers
6	rain and snow mixed
7	freezing rain, freezing drizzle
8	ice pellets, ice pellets and rain mixed

It should be noted that this is a conditional forecast; that is, it is a forecast of the type of precipitation if precipitation occurs. Therefore, one of the 8 code numbers is always recorded. In this verification,

a forecast of 4, 5, or 8 is interpreted as "snow".

The "guidance" forecast is a probability of the occurrence of frozen precipitation, given that precipitation occurs; therefore, it is also a conditional forecast and is available whether or not precipitation occurs. Frozen precipitation includes the types of precipitation defined by code numbers 4, 5, and 8 used for the local forecast. In this verification, a guidance forecast of "snow" is defined as a PoFP(P) of $\geq$ 50 percent.

The verifying observations were those purchased from the National Weather Records Center in Asheville, N.C. and described by Glahn (1973). Any observation corresponding to code numbers 4, 5, or 8 above was considered as "snow"; any other observation of precipitation was considered as "rain".

In the operational system, guidance forecasts are valid for projections of 12, 24, 36, and 48 hours. Therefore, in order to match the valid times for the local forecasts, the guidance forecasts from the 0000 GMT initial data time were interpolated to 18-, 30-, and 42-hour projections. It should be noted that the locals had the advantage of about nine hours later data because of the 1000 GMT issuance time. Therefore, the 18-, 30-, and 42-hour projections for the guidance forecasts (valid at 1800 GMT (today), 0600 GMT (tonight), and 1800 GMT (tomorrow), respectively) correspond to approximately 9-, 21-, and 33-hour projections respectively for the local forecasts.

The verification sample consisted of data for the 91 conterminous U.S. stations listed in Table 1 for the months of February through April 1974. The verification scores used were percent correct, bias, and Heidke skill score[1].

The verification was divided into two parts, A and B. For verification A, all cases, both the obvious and the difficult, were included. In verification B, only those cases when the guidance and local forecasts of precipitation type differed were included; therefore, some of the more difficult forecast situations were isolated. Tables 2 and 3 and Tables 4 and 5 show the results for verifications A and B respectively. For verification A, contingency tables for the 18-, 30-, and 42-hour projections are shown in Table 2. The verification scores computed from contingency tables for each NWS region and for all 91 stations combined are shown in Table 3. A similar arrangement of tables is presented for verification B (Tables 4 and 5), except that the verification scores are not provided for each NWS region because of the small number of cases involved. Also,

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[1]Bias is defined as number forecast/number observed. Other scores are defined in Glahn and Bocchieri (1974).

in verification B, only the percent correct is computed because the other scores are not very meaningful for this specialized sample.

The results for verification A can be summarized as follows:

1. For each region and for all stations combined, guidance was better than the locals for all scores and projections.

2. Overall, guidance had a slight tendency to underforecast the snow event for the daytime periods (bias <1.00); the locals showed a stronger tendency to underforecast for all periods.

3. Percents correct and skill scores were rather high because the sample contained many cases when the form of precipitation would be rather obvious.

The results for verification B are summarized below:

1. For all stations combined, guidance was better than the locals for all projections.

2. Guidance showed more improvement over locals than in verification A.

Similar verification results were obtained when the guidance forecasts were compared to subjective precipitation type forecasts prepared by the Basic Weather Forecast Branch of the National Meteorological Center for the period October 1972 through March 1973 (see Glahn and Bocchieri, 1974).

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REFERENCES

Glahn, H. R., "The TDL MOS Development System CDC 6600 Version," TDL Office Note 73-5, 1973, 72 pp.

_____, and J. R. Bocchieri, "Predicting the Conditional Probability of Frozen Precipitation," NOAA Technical Memorandum NWS TDL-51, 1974, 33 pp.

_____, and D. A. Lowry, "The Use of Model Output Statistics (MOS) in Objective Weather Forecasting," Journal of Applied Meteorology, Vol. 11, No. 8, 1972, pp. 1203-1211.

NWS, "Operational Forecasts Derived from Primitive Equation and Trajectory Model Output Statistics (PEATMOS)--4," Technical Procedures Bulletin, No. 83, 1973a, 6 pp.

NWS, "Combined Aviation/Public Weather Forecast Verification," National Weather Service Operations Manual, Chapter C-73, 1973b, 14 pp.

NWS, "Operational Probability of Precipitation Forecasts Based on Model Output Statistics (MOS)--No. 7," Technical Procedures Bulletin, No. 109, 1974a, 7 pp.

NWS, "Guidance Material Available in the Request Reply System of Service A," Technical Procedures Bulletin, No. 116, 1974b, 7 pp.

Table 1. Ninety-one[1] stations used in the comparative verification of guidance and local forecasts of precipitation type. Listing is by NWS Region--Eastern, Southern, Central, and Western.

PWM	Portland, Maine	ABQ	Albuquerque, New Mexico
BTV	Burlington, Vermont	SSM	Sault Ste Marie, Michigan
CON	Concord, New Hampshire	DTW	Detroit, Michigan
BOS	Boston, Massachusetts	SBN	South Bend, Indiana
PVD	Providence, Rhode Island	IND	Indianapolis, Indiana
HFD	Hartford, Connecticut	LEX	Lexington, Kentucky
BUF	Buffalo, New York	SDF	Louisville, Kentucky
SYR	Syracuse, New York	MSN	Madison, Wisconsin
ALB	Albany, New York	MKE	Milwaukee, Wisconsin
JFK	New York, New York	ORD	Chicago, Illinios
ERI	Erie, Pennsylvania	SPI	Springfield, Illinios
PIT	Pittsburgh, Pennsylvania	STL	St. Louis, Missouri
ABE	Allentown, Pennsylvania	MCI	Kansas City, Missouri
PHL	Philadelphia, Pennsylvania	TOP	Topeka, Kansas
CLE	Cleveland, Ohio	DDC	Dodge City, Kansas
CMH	Columbus, Ohio	DEN	Denver, Colorado
CRW	Charleston, West Virginia	GJT	Grand Junction, Colorado
HTS	Huntington, West Virginia	SHR	Sheridan, Wyoming
DCA	Washington, D. C.	CYS	Cheyenne, Wyoming
ORF	Norfolk, Virginia	BIS	Bismarck, North Dakota
RDU	Raliegh-Durham, North Carolina	FAR	Fargo, North Dakota
CLT	Charlotte, North Carolina	RAP	Rapid City, South Dakota
CAE	Columbia, South Carolina	FSD	Sious Falls, South Dakota
CHS	Charleston, South Carolina	BFF	Scottsbluff, Nebraska
ATL	Atlanta, Georgia	OMA	Omaha, Nebraska
SAV	Savannah, Georgia	MSP	Minneapolis, Minnesota
MIA	Miami, Florida	DSM	Des Moines, Iowa
JAX	Jacksonville, Florida	BRL	Burlington, Iowa
BHM	Birmingham, Alabama	INL	International Falls, Minnesota
MOB	Mobile, Alabama	FLG	Flagstaff, Arizona
TYS	Knoxville, Tennessee	PHX	Phoenix, Arizona
MEM	Memphis, Tennessee	SLC	Salt Lake City, Utah
MEI	Meridian, Mississippi	RNO	Reno, Nevada
JAN	Jackson, Mississippi	SAN	San Diego, California
MSY	New Orleans, Louisianna	LAX	Los Angeles, California
SHV	Shreveport, Louisianna	FAT	Fresno, California
IAH	Houston, Texas	SFO	San Francisco, California
SAT	San Antonio, Texas	PDX	Portland, Oregon
DFW	Fort Worth, Texas	PDT	Pendleton, Oregon
ABI	Abilene, Texas	SEA	Seattle, Washington
LBB	Lubbock, Texas	GEG	Spokane, Washington
ELP	El Paso, Texas	BOI	Boise, Idaho
LIT	Little Rock, Arkansas	PIH	Pocatello, Idaho
FSM	Fort Smith, Arkansas	MSO	Missoula, Montana
TUL	Tulsa, Oklahoma	GTF	Great Falls, Montana
OKC	Oklahoma City, Oklahoma		

[1]Local forecasts for Farmington, New Mexico were not available for April.

Table 2. Contingency tables for guidance and local forecasts (verification A).

Projection (Hrs)	Observed	Forecast				Total
		Guidance		Locals		
		Snow	Rain	Snow	Rain	
18	Snow	295	36	249	82	331
	Rain	25	427	22	430	452
	Total	320	463	271	512	783
30	Snow	303	27	274	56	330
	Rain	35	438	34	439	473
	Total	338	465	308	495	803
42	Snow	270	46	220	96	316
	Rain	31	430	24	437	461
	Total	301	476	244	533	777

Table 3. Comparative verification of guidance and local forecasts by NWS Region (verification A).

Projection (Hrs)	Region	System	Bias Snow	Bias Rain	Percent Correct	Skill Score	Number of Cases
18	Eastern	Guidance	1.00	1.00	91	.81	306
		Locals	.88	1.09	87	.72	
	Southern	Guidance	.50	1.04	97	.65	86
		Locals	.67	1.02	96	.58	
	Central	Guidance	.96	1.06	92	.83	272
		Locals	.76	1.34	84	.68	
	Western	Guidance	.97	1.01	94	.86	119
		Locals	.85	1.06	87	.68	
	All Stations	Guidance	.97	1.02	92	.84	783
		Locals	.82	1.13	87	.72	
30	Eastern	Guidance	1.02	.98	93	.86	300
		Locals	.97	1.02	89	.77	
	Southern	Guidance	.80	1.01	99	.88	85
		Locals	1.00	1.00	95	.58	
	Central	Guidance	1.01	.98	90	.81	295
		Locals	.91	1.12	87	.74	
	Western	Guidance	1.14	.96	90	.74	123
		Locals	.90	1.03	89	.70	
	All Stations	Guidance	1.02	.98	92	.84	803
		Locals	.93	1.05	89	.77	
42	Eastern	Guidance	1.00	1.00	91	.81	292
		Locals	.92	1.05	89	.76	
	Southern	Guidance	.43	1.05	95	.56	84
		Locals	.29	1.06	94	.42	
	Central	Guidance	.94	1.08	89	.78	277
		Locals	.69	1.40	79	.59	
	Western	Guidance	.97	1.01	86	.67	124
		Locals	.73	1.11	81	.50	
	All Stations	Guidance	.95	1.03	90	.79	777
		Locals	.77	1.16	85	.67	

Table 4. Contingency tables for guidance and local forecasts (verification B)

Projection (Hrs)	Observed	Forecast				Total
		Guidance		Locals		
		Snow	Rain	Snow	Rain	
18	Snow	52	6	6	52	58
	Rain	13	10	10	13	23
	Total	65	16	16	65	81
30	Snow	38	9	9	38	47
	Rain	19	18	18	19	37
	Total	57	27	27	57	84
42	Snow	57	7	7	57	64
	Rain	13	6	6	13	19
	Total	70	13	13	70	83

Table 5. Comparative verification of guidance and local forecasts (verification B).

Projection (Hrs)	Forecast	Percent Correct	Number of Cases
18	Guidance	76	81
	Locals	24	
30	Guidance	67	84
	Locals	33	
42	Guidance	76	83
	Locals	24	